

**REMARKS**

**I. STATUS OF THE CLAIMS**

Claims 1 and 16 are amended herein. No new matter has been added.

Claims 7-13 are withdrawn.

In view of the above, it is respectfully submitted that claims 1-6 and 14-18 are currently pending.

**II. INTRODUCTION**

The Examiner's arguments with respect to Applicant's election with traverse are noted.

With respect to Paragraph 1 of the detailed action, Applicant repeats that there have been no references cited to show any necessity for requiring restriction.

Applicant repeats that the Examiner has not set forth why there would be a serious burden if restriction is not required. The Examiner's statement that "the claims of Group II, are not limited by process limitations and therefore the under bump metallization may be made by any process, such as selective deposition" is in the realm of speculation and Applicant repeats that references are specifically required by the Examiner to bolster his statement.

Notwithstanding these arguments, Applicant is proceeding under the traversal election.

Applicant appreciates the Examiner's statement that the restriction (election) requirement was timely traversed in the reply of the Applicant filed on May 5, 2005.

**III. REJECTIONS UNDER 35 U.S.C. § 102**

In item 5, on page 3 of the Office Action, claims 1, 5, 6 and 15-17 were rejected under 35 U.S.C. § 102(e) as being anticipated by Datta (US 6,750,133).

Claims 1 and 16 as amended specifically recite, amongst other novel features, "**solder bumps to which the copper layer is diffused**". (Emphasis Added). Datta fails to disclose, teach or suggest this feature.

Instead, Datta relates to a ball-limiting metallurgy (BLM) stack wherein a metal first layer is disposed above and on the metallization and a metal second layer is disposed above and on the metal first layer. **A copper stud is disposed over the metal second layer, and an**

electrically conductive bump is disposed above and on the copper stud. See, for example, FIG. 13, column 2, lines 19-28 and column 9, lines 23-25 of Datta.

Therefore, it is respectfully submitted that Datta fails to disclose, teach or suggest **"solder bumps to which the copper layer is diffused"** as specifically recited by Applicant in, for example, claims 1 and 16. That is, Datta does not disclose the diffusion of the copper stud to bump precursor. The copper layer of the present invention diffuses to the solder to form a copper-containing alloy whereas Datta is silent about the formation of copper-containing alloy. Further understanding and appreciation of Applicant's invention would be found in, for example, FIG. 2B, and paragraphs [0022]-[0024] of the specification of this present application.

Moreover, it is respectfully submitted that in Datta the metallization 14 is a copper pad that makes connection to M6 or M7 devices. (Col. 2, lines 50-53). Applicant's protective layer 14 is not plated over the open electrode pad as in Datta where it is later etched away. Further, Applicant does not utilize a nitride layer 18 or passivation layer 20 formed over a substrate 12 as in Datta. Instead, Applicant specifically recites **"an under bump metallization (UBM) layer on the wafer"** which is not etched away over the open electrode pad as in Datta.

Furthermore, Applicant does not utilize a precursor [34] SiC as in Datta (Col. 5, lines 31-45). In this regard, Applicant's invention specifically recites **"lead-free solder bumps"** whereas **Datta teaches the use of lead alloys in solder.** (Col. 5, lines 11-12, 48). The first metal layer 26 and second metal layer 28 of Datta do not teach the UBM layer of Applicant in that Applicant does not utilize two etching processes as in Datta to wash away the layer 16 and 18 of Applicant as Datta does to layers 26 and 28.

More specifically, claim 1 of the present application recites lithographing a photoresist on the UBM layer, excluding a portion of the UBM layer corresponding to the electrode pad; forming a copper layer on the portion of the UBM layer corresponding to the electrode pad; plating solder on the copper layer; removing the photoresist; and etching the UBM layer using the solder as a mask, and reflowing the solder and fabricating the solder bumps. It is respectfully submitted that Datta fails to disclose, teach or suggest the specifics of Applicant's invention as specifically recited in, for example, claim 1.

In view of the above, it is respectfully submitted that the rejection is overcome.

Although the above comments are specifically directed to claims 1 and 16, it is respectfully submitted that the comments would be helpful in understanding differences in claims 5, 6, 15 and 17 over the cited references.

#### IV. REJECTIONS UNDER 35 U.S.C. § 103(a)

In item 8, on page 4 of the Office Action, claims 2 and 3 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Datta as applied to claim 1, and further in view of Cheung (U.S. 6,638,847).

Applicant respectfully submits that in addition to the differences in Applicant's invention, as explained above, Cheung discusses utilizing copper as a constituent of the solder being applied to form bumps whereas Applicant's invention provides a method of easily fabricating binary lead-free solder bumps with only unitary tin plating, or tin-silver copper ternary lead-free solder bumps with only binary tin-silver plating by diffusing copper into solders when reflowing the solders by relayering the copper on an UBM layer under the solder bump. This allows Applicant to achieve a lower cost fabrication process by diffusing the amount of copper using temperature and time controls.

Cheung teaches against Applicant's invention at Col. 6, lines 13-19, by teaching that you must use copper in the solder that is applied to the bumps, whereas Applicant does not.

Therefore, it is respectfully submitted that nothing was cited or has been found in Cheung suggesting modification of Datta to overcome the deficiencies discussed above. Since, claims 2 and 3 depend from claim 1, it is submitted that claims 2 and 3 patentably distinguish over Datta for the reasons discussed above with respect to claim 1.

In view of the above, it is respectfully submitted that the rejection is overcome.

In item 10, on page 5 of the Office Action, claim 4 was rejected under 35 U.S.C. § 103(a) as unpatentable over Datta and in further view of Darbha (U.S. 5,904,555).

Datta does not disclose Applicant's use of diffusion from a copper layer into a solder ball to form a binary or ternary lead-free solder bump, and neither does the glass encapsulation technique taught by Darbha.

With regard to the result-effective variables discussed by Darbha in view of In Re Boesch 205USPQ215, cited by the Examiner, Applicant submits that in Boesch the reference against Boesch disclosed alloys having compositional limits overlapping those of the claimed alloys; also, in Boesch it was known in the trade that the higher the  $N_v$  value of a Co-Cr-Ni alloy, the higher the chance for precipitation of embrittling phases (pg. 219, col. 1, 2<sup>nd</sup> paragraph), and this

was known to those who worked in the art.

Applicant's invention is different from every reference cited. Applicant submits that to "determine" the time and temperature of solder reflow is easy after reading applicant's invention application. Further understanding and appreciation of Applicant's invention as recited in claim 4 is found in, for example, page 4, Table 1 of the specification of this present application. None of the references teach or show copper diffusion into a lead-free solder ball during reflow. Claim 4 is therefore submitted to be allowable.

Furthermore, reflowing for about 1 to 20 minutes at a temperature of about 220° to about 270°C relate to the requirements for diffusing copper into solders and this is another argument for traversal of the election requirements.

Moreover, nothing was cited or has been found in Darbha suggesting modification of Datta to overcome the deficiencies discussed above with respect to claim 1. Since, claim 4 depends from claim 1, it is submitted that claim 4 patentably distinguish over Datta for the reasons discussed above with respect to claim 1.

In view of the above, it is respectfully submitted that the rejection is overcome.

In item 12, on page 6 of the Office Action, claims 14 and 18 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Datta, as applied to claims 1 or 16, in view of Leibovitz (US 6,146,984).

In this regard Applicant submits that Leibovitz discusses producing uniform solder bumps by creating uniform current density across a die pattern. Neither Leibovitz nor Datta discuss, teach, or show diffusion of copper into the solder ball as in Applicant's invention. The selective etching sequence is irrelevant in regard to Applicant's invention.

Moreover, nothing was cited or has been found in Leibovitz suggesting modification of Datta to overcome the deficiencies discussed above with respect to claim 1. Since, claims 14 and 18 depend from claims 1 and 16 respectively, it is submitted that claims 14 and 18 patentably distinguish over Datta for the reasons discussed above with respect to claims 1 and 16.

In view of the above, it is respectfully submitted that the rejection is overcome.

**V. CONCLUSION**

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

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